Difficult Run and Accotink Creek Bacteria and Benthic TMDLs Development

TAC Meeting #2

November 28, 2007

Agenda:

- **Recap of TAC Meeting #1**
  - Discussed what is a TMDL? Why? and how?
  - Presented the listed segments of the Difficult Run and Accotink Creek Watersheds
  - Discussed steps used in the TMDL development
  - Discussed the data used in the TMDL development
- **Discuss Land Use Reclassification**
- **Present Bacteria TMDL Inventories**
- **Discuss Bacteria TMDL Technical Approach**
- **Present Stressor Identification for Difficult Creek**
- **Discuss Stressor Identification for Accotink Creek**

Land Use Reclassification

- New land use data available from the Virginia Department of Forestry (2005)
- Create hybrid land use layer by combining NLCD 2001 data with DOF's data
- Reclassification will better reflect growth in the watershed
- Reclassified land use will be used in TMDL development
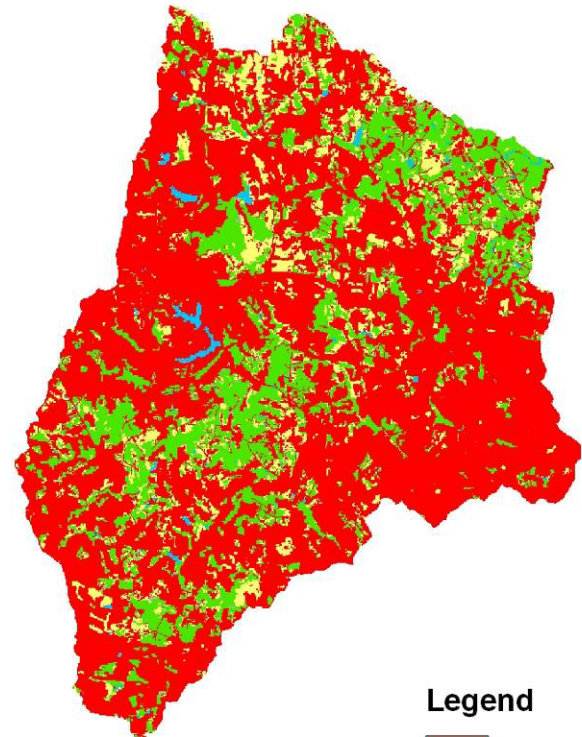
Difficult Run Watershed Land Use
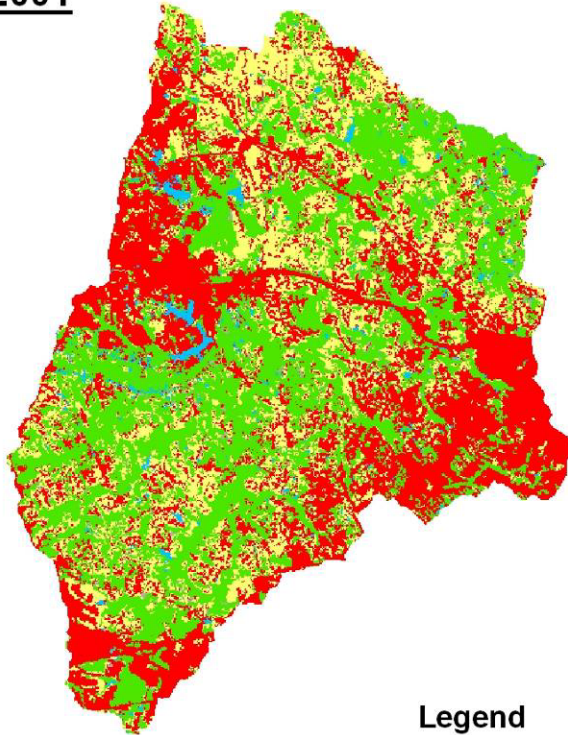
NLCD 2001
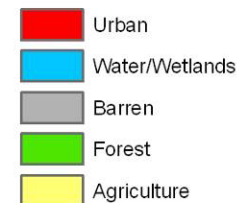
Land Cover Type	Acres
Urban	13,236
Water/Wetlands	652
Barren	268
Forest	14,067
Agriculture	9,037
Total	37,260

Legend
- Urban
- Water/Wetlands
- Barren
- Forest
- Agriculture

NLCD 2001 - DOF 2005 Hybrid

Land Cover Type	Acres
Urban	25,381
Water/Wetlands	337
Barren	111
Forest	7,478
Agriculture	3,953
Total	37,260

Legend
- Urban
- Water/Wetlands
- Barren
- Forest
- Agriculture

Accotink Creek Watershed Land Use
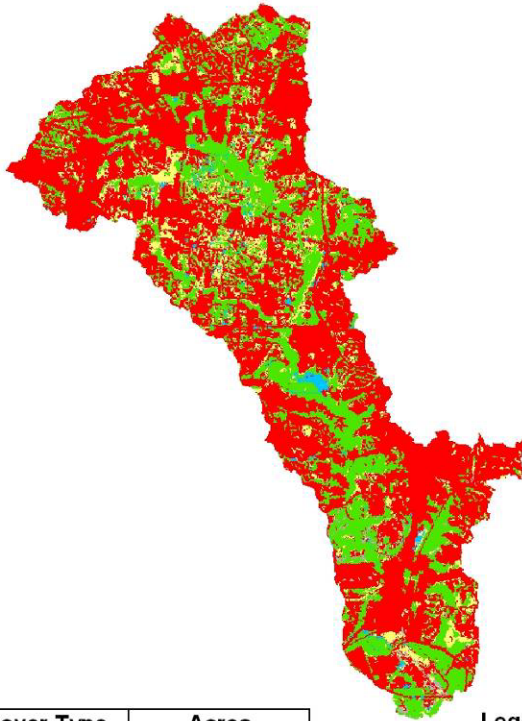
NLCD 2001

Land Cover Type	Acres
Urban	19,010
Water/Wetlands	407
Barren	278
Forest	8,386
Agriculture	2,809
Total	30,890

Legend
- Urban
- Water/Wetlands
- Barren
- Forest
- Agriculture
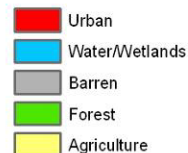
NLCD 2001 - DOF 2005 Hybrid
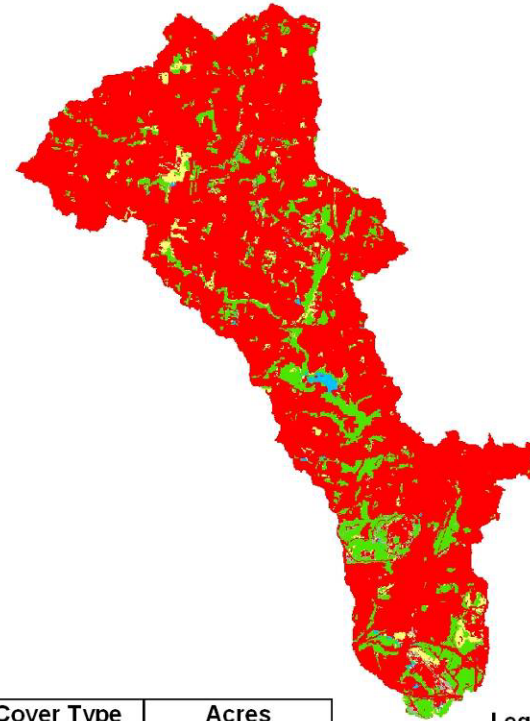
Land Cover Type	Acres
Urban	25,708
Water/Wetlands	172
Barren	180
Forest	3,768
Agriculture	1,061
Total	30,890

Legend
- Urban
- Water/Wetlands
- Barren
- Forest
- Agriculture
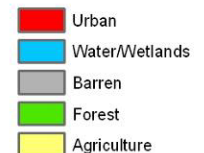
Bacteria TMDL: Difficult Run

Difficult Run Watershed
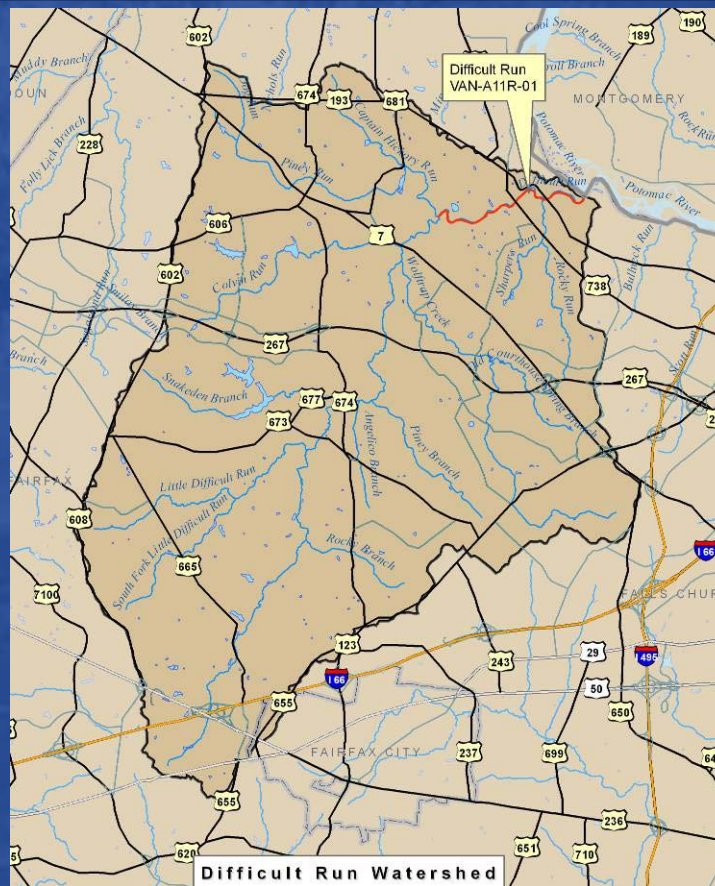
TMDL ID	Stream Name	Length (miles)	Boundaries	Listing Station ID:	Impairment for	Exceedance Rate*
VAN-A11R-01	Difficult Run	2.93	Confluence of Captain Hickory Run downstream to the confluence with the Potomac River	1ADIF000.86	Total Fecal Coliform (listed in 1994)	19/85 (22%)
					E. Coli (Listed in 2004)	5/21 (24%)

* Based on DEQ water quality data collected between 1995 and 2006

Bacteria TMDL: Accotink Creek

Upper Accotink Creek:

TMDL Approved by DEQ and EPA (2003)

Completed TMDL Upper Accotink Creek VAN-A15R-02

TMDL Study Area Lower Accotink Creek VAN-A15R-01
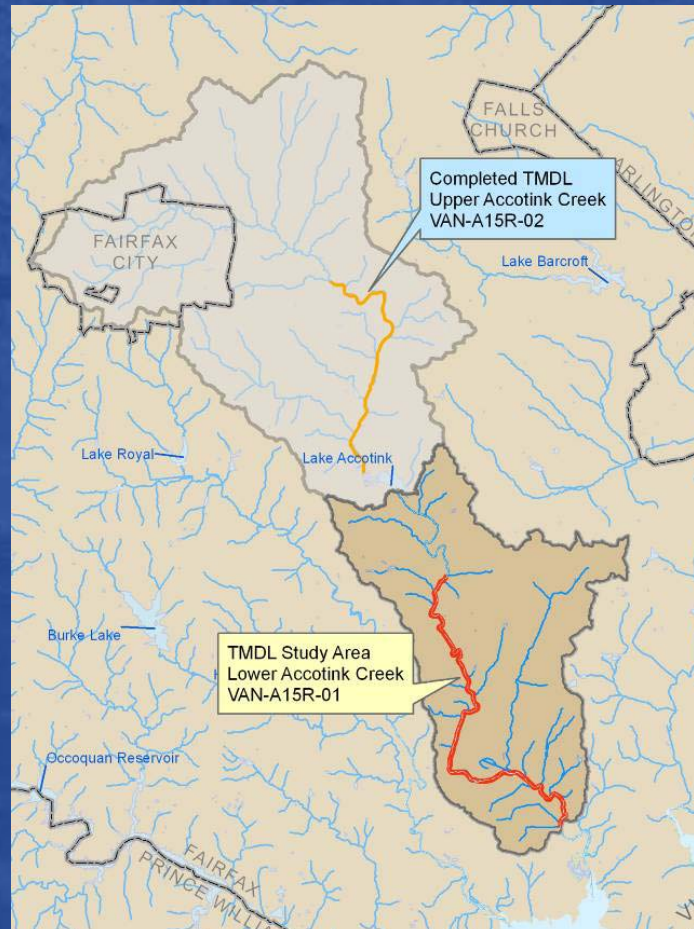
Lower Accotink Creek:

Current TMDL Study Watershed

TMDL ID	Stream Name	Length (mi)	Boundaries	Station ID:	Impairment for	Exceedance Rate*
VAN-A15R-01	Accotink Creek	7.35	Confluence of Calamo Branch to end of free-flowing waters (Rt. 1)	1AACC006.10	Fecal Coliform	11/66 (17%)

* Based on DEQ water quality data collected between 1995 and 2006
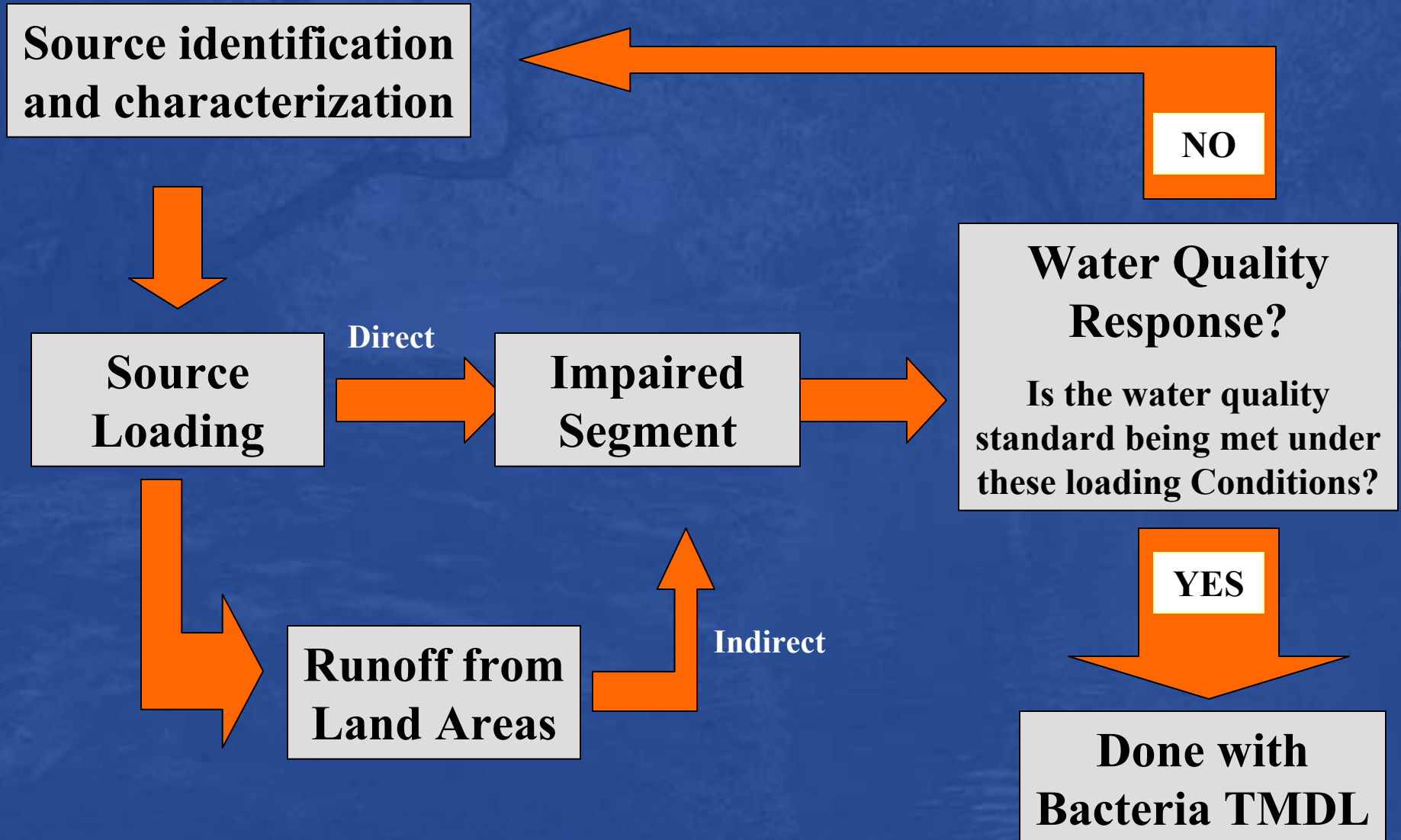
Bacteria Sources

- **Bacteria loading from <u>Human Sources</u>**
  - Permitted Sources
  - Straight pipes
  - Septic systems
  - Land Application of Biosolids

- **Bacteria loading from <u>Livestock</u>**
  - Livestock inventory
  - Livestock grazing and stream access
  - Confined animal facilities
  - Manure management

- **Bacteria loading from <u>Wildlife</u>**
  - Wildlife Inventories

- **Bacteria loading from <u>Pets</u>**
  - Pet Inventories

Source Loading Estimates

- **Determine the daily fecal coliform production by source**
- **Estimate the size/number of each source**
- **Determine whether the source is**
  - ➢ Direct Source
  - ➢ Indirect Source
- **Calculate the load to each land use based on a monthly schedule and for each source**
- **The sum of all the individual sources is the total load**
- **Source loading estimates used in HSPF model to simulate in-stream bacteria concentrations**

Population Estimates and Sewage Disposal

Based on 2004 US Census Data

Difficult Run Watershed:

Watershed	Total Population	Total Households	Houses on:			
			Sewer	Septic	Failed Septic*	Other means
Fairfax County	123,430	48,155	44,967	3,087	50	~0
Fairfax City	849	320	316	4	0	~0
Total	**124,279**	**48,476**	**45,284**	**3,091**	**50**	**~0**

*Failure Rate: 1.62% from NVPDC, 1990

Accotink Creek Watershed:

Watershed	Total Population	Total Households	Houses on:			
			Sewer	Septic	Failed Septic*	Other means
Upper[1]	110,000	40,741	39,727	1,014	16	~0
Lower[2]	51,624	16,237	15,162	1,041	17	~0
Total	**161,624**	**56,978**	**54,889**	**2,055**	**33**	**~0**

[1]Estimates based on 2000 US Census Data
[2]Estimates based on 2004 US Census Data
*Failure Rate: 1.62% from NVPDC, 1990

Livestock Estimates

Livestock numbers are based on the Fairfax County 2002 US Agricultural Census data and the horse numbers are based on the 2001 VA Agricultural Statistics Equine report.

Difficult Run Watershed		
Livestock Type	**Total Using 2001 NLCD**	**Total Using NLCD 2001-DOF 2005 Hybrid**
Beef cows	119	54
Milk cows	3	1
Hogs and pigs inventory	20	9
Sheep and lambs inventory	34	16
Chickens	133	60
Horses and ponies, inventory	795	359

Lower Accotink Creek Watershed		
Livestock Type	**Total Using 2001 NLCD**	**Total Using NLCD 2001-DOF 2005 Hybrid**
Beef cows	6	3
Milk cows	0	0
Hogs and pigs inventory	1	1
Sheep and lambs inventory	2	1
Chickens	7	4
Horses and ponies, inventory	41	23

Wildlife Estimates for Difficult Run

Estimates are based on from DGIF and the distribution estimates from the Upper Accotink Creek Watershed TMDL (USGS, 2003)

Wildlife Animal	Total Using NLCD 2001	Total Using NLCD 2001-DOF 2005 Hybrid	Total Using NLCD 2001-DOF 2005 Hybrid and Densities from Recent Urban TMDL
Deer*	2,098	1,501	2,261
Raccoon*	6,637	3,453	1,865
Muskrat*	2,981	324	889
Beaver	534	534	222
Goose-Summer*	3,010	5,710	5,710
Goose Winter*	3,215	6,100	6,100
Duck Summer*	578	725	725
Duck Winter*	838	1,106	1,106
Wild Turkey	373	373	15

* Estimates based on Upper Accotink TMDL distributions, all others are based on DGIF estimates

Wildlife Estimates for Accotink Creek

Estimates are based on distribution estimates from DGIF and the distribution estimates from the Upper Accotink Creek Watershed TMDL (USGS, 2003)

Wildlife Animal	Total Using NLCD 2001	Total Using NLCD 2001-DOF 2005 Hybrid	Total Using NLCD 2001-DOF 2005 Hybrid and Densities from Recent Urban TMDL
Deer*	571	424	636
Raccoon*	2,616	791	2,273
Muskrat*	457	292	290
Beaver	174	174	73
Goose-Summer*	3,446	2,201	2,201
Goose Winter*	4,730	4,647	4,647
Duck Summer*	213	206	206
Duck Winter*	667	634	634
Wild Turkey	114	114	2

Pet Estimates

Pet inventories based on:

- 0.543 Dogs per household*
- 0.598 Cats per household*

*Source: American Veterinary Medical Association (AVMA) estimates

In the Difficult Run Watershed there are approximately:

- 26,322 Dogs
- 28,746 Cats

- In the Accotink Creek Watershed there are approximately:

Watershed	Dogs	Cats
Upper*	9,735	22,186
Lower	8,817	9,580
Total	18,552	31,766

*Based on Accotink TMDL (2003) estimates of 2 cats per 3 people and 1 dog per 8 people

Point Source Inventory

Watershed	Permit Type	Count (Active or Application)
Lower Accotink Creek	Individual Permits	5
	General Permits	28
	MS4 Permits	6
	Total	39
Difficult Run	Individual Permits	3
	General Permits	9
	MS4 Permits	5
	Total	17

BST Data from 1AACO006.10
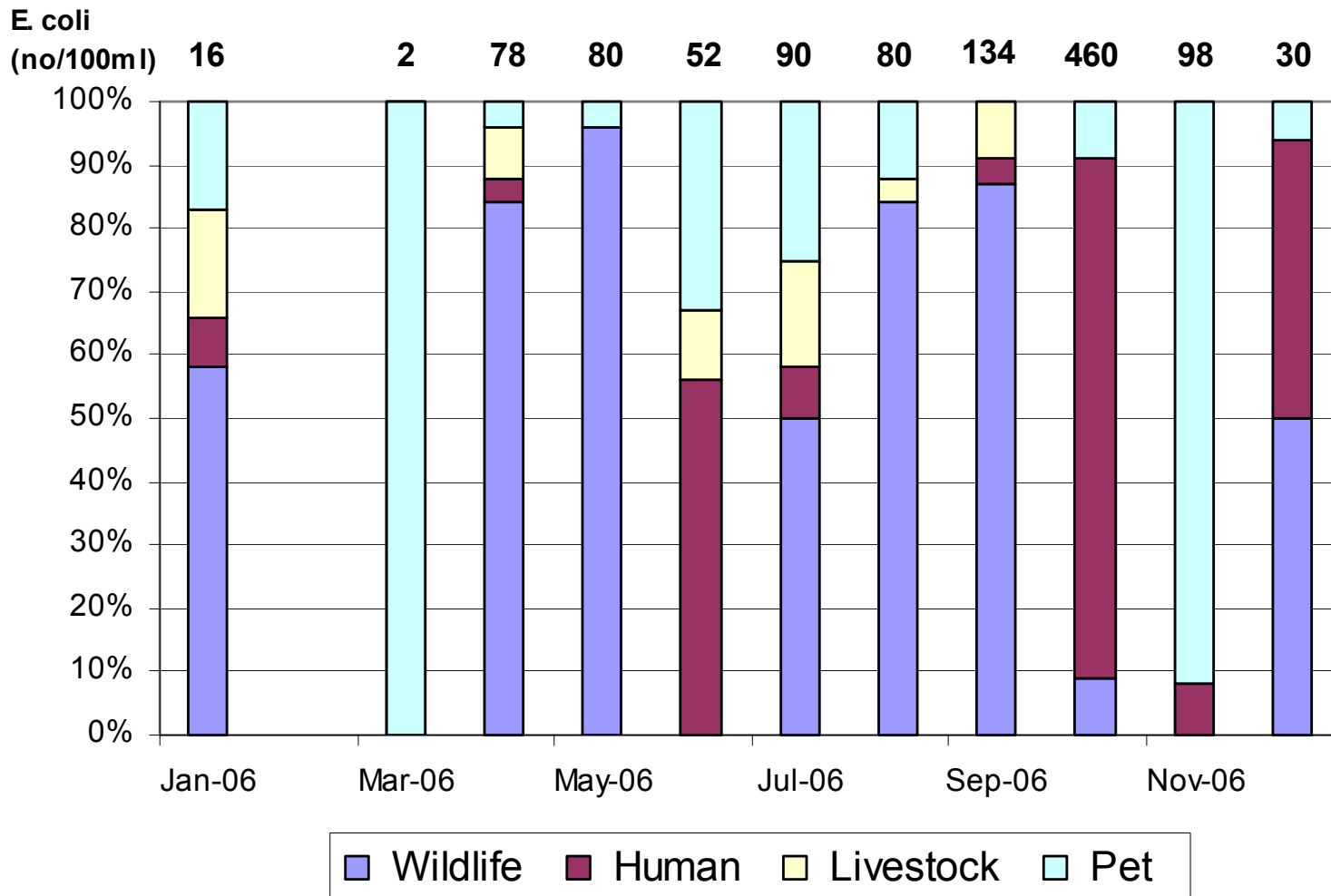
Water Quality Model: HSPF

Hydrologic **S**imulation **P**rogram **F**ortran

Input ➡ **Model** ➡ **Output**

Factors:

Rainfall events

Fecal coliform build up

Fecal coliform wash off

Fecal coliform die off rates

Watershed Boundary

Land use

Soil

Stream

Pollutant Sources

River Response
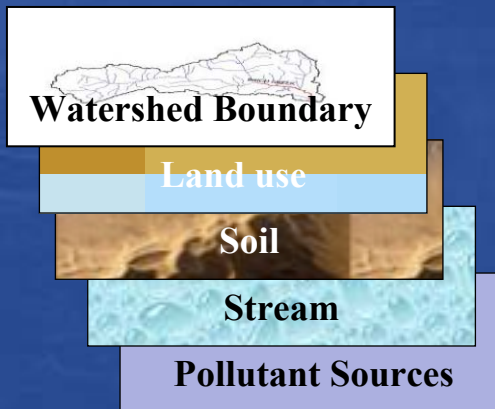
HSPF Model Setup for Difficult Run

- **Difficult Run Watershed delineated to <u>28</u> model segments for bacteria loadings**

- **Hydrologic Model Calibration/Validation**
  - ➢ USGS Flow Station 01646000
- **Water quality Model Calibration/Validation**
  - ➢ Using DEQ water quality stations on impaired segment
- **Weather data:**
  - ➢ NCDC data from National Airport
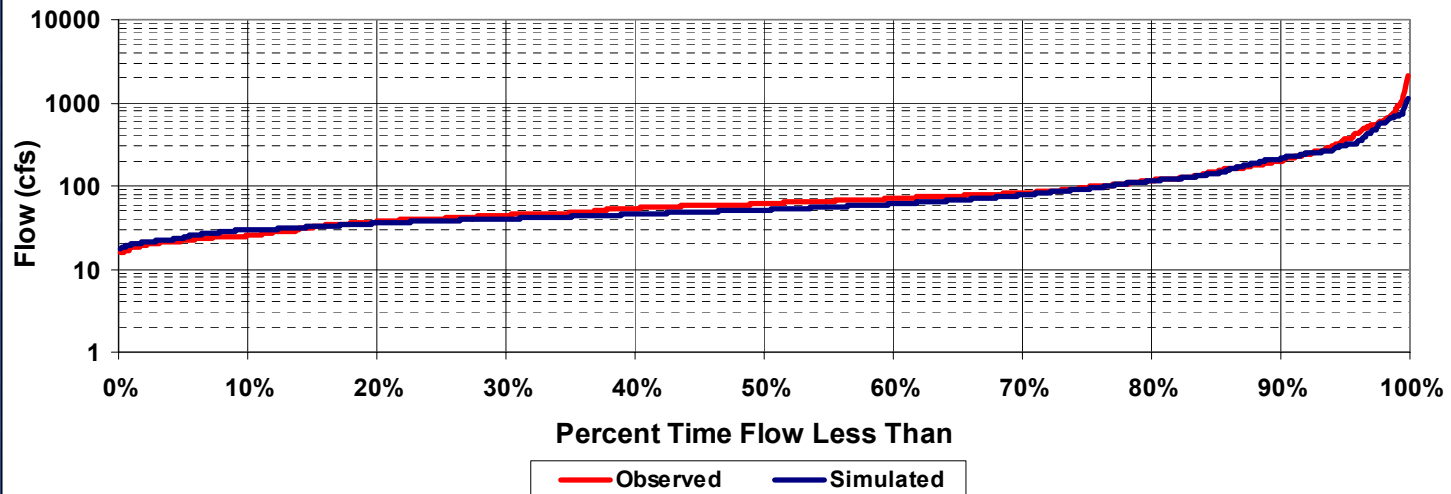
Difficult Run HSPF Model Segmentation
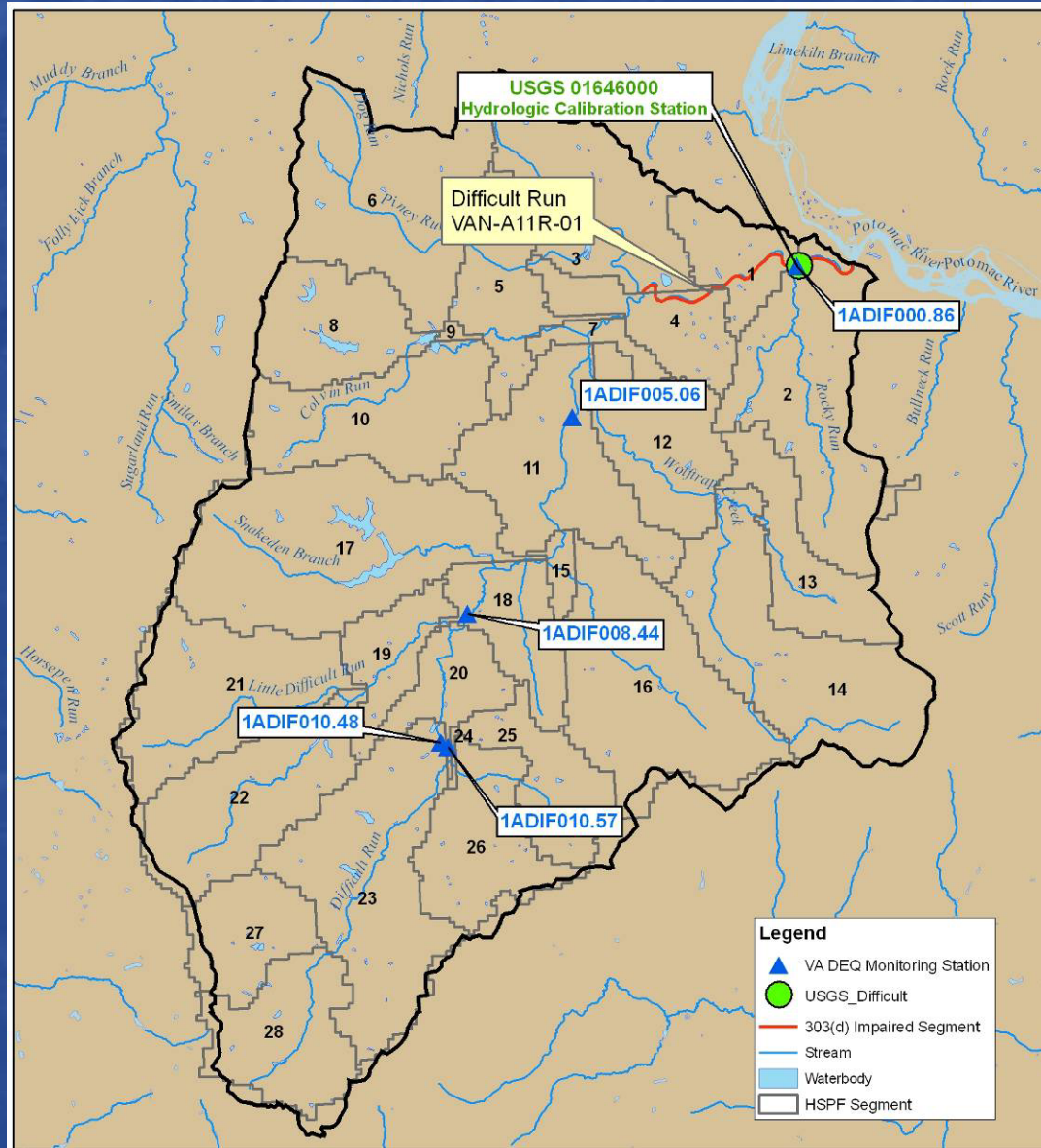
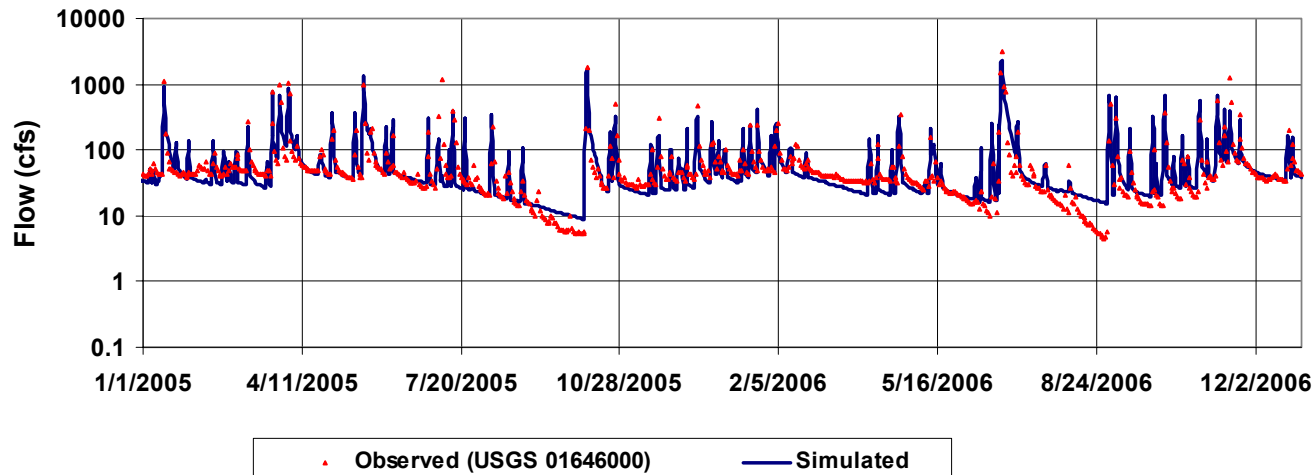# Difficult Run HSPF Hydrological Calibration

Difficult Run Flow Calibration 2003-2004

Difficult Run HSPF Hydrological Validation

Difficult Run Flow Validation 2005-2006

# HSPF Model Setup for Accotink Creek

- **Accotink Creek Watershed delineated to <u>35</u> model segments for bacteria loadings**

- **Hydrologic Model Calibration/Validation**
  - USGS Flow Station 01654000
- **Water quality Model Calibration/Validation**
  - Using DEQ water quality stations on impaired segment
- **Weather data:**
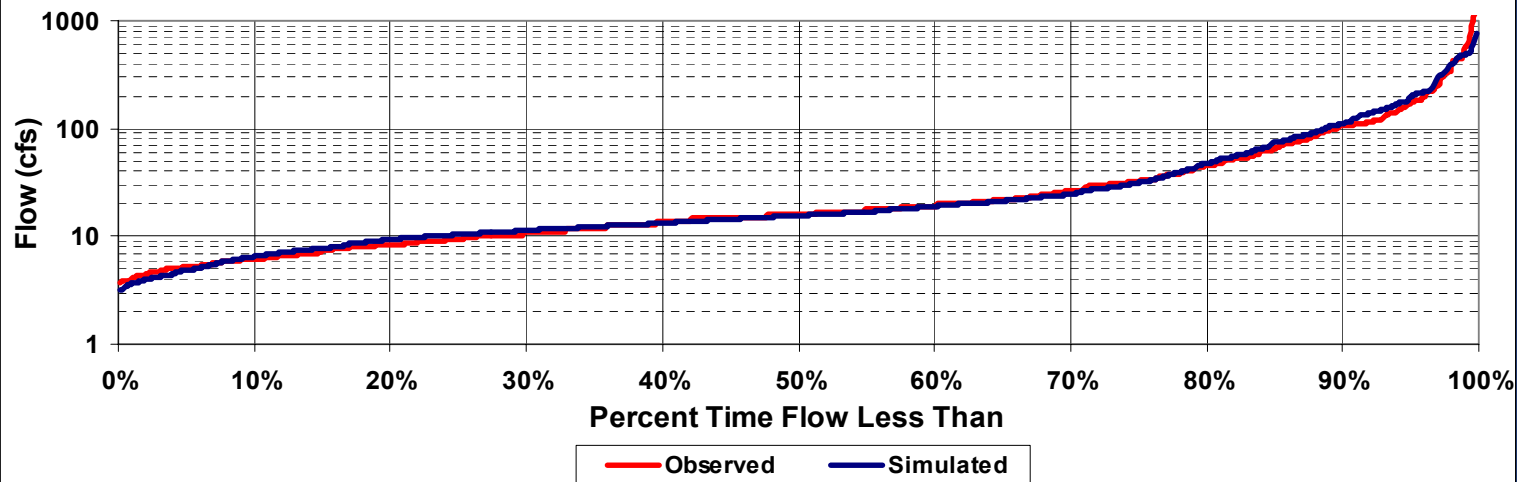 - NCDC data from National Airport

Accotink Creek HSPF Hydrological Calibration

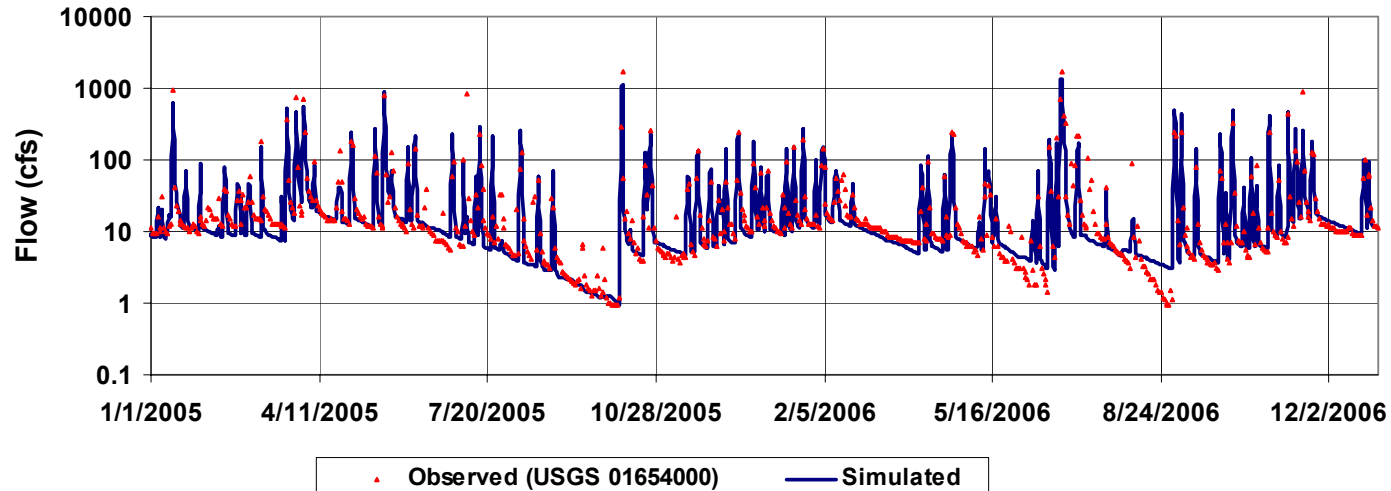Accotink Creek Flow Calibration 2003-2004
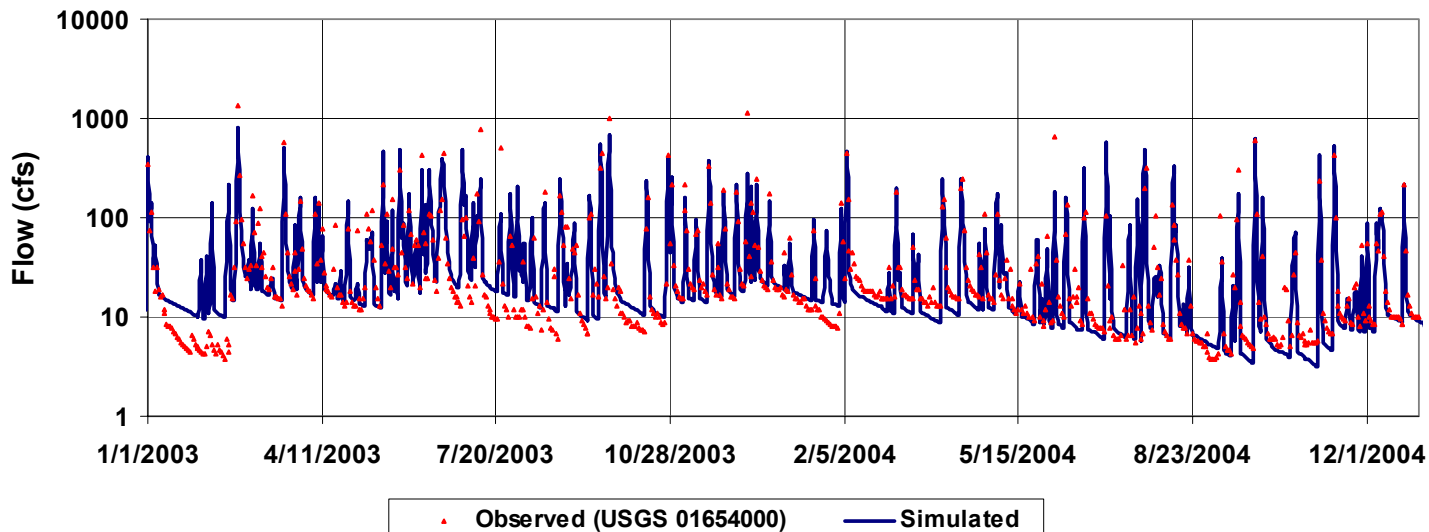
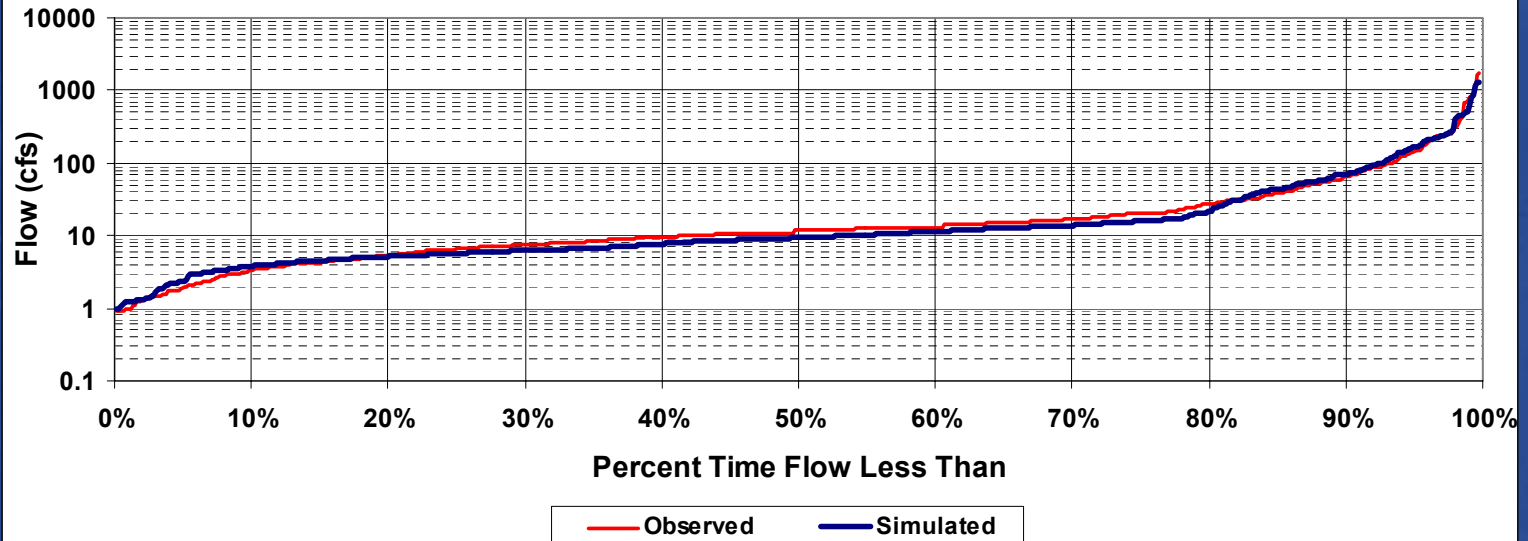Frequency Distribution of Observed and Simulated Flows Calibration

Accotink Creek HSPF Hydrological Validation

Accotink Creek Flow Validation 2005-2006

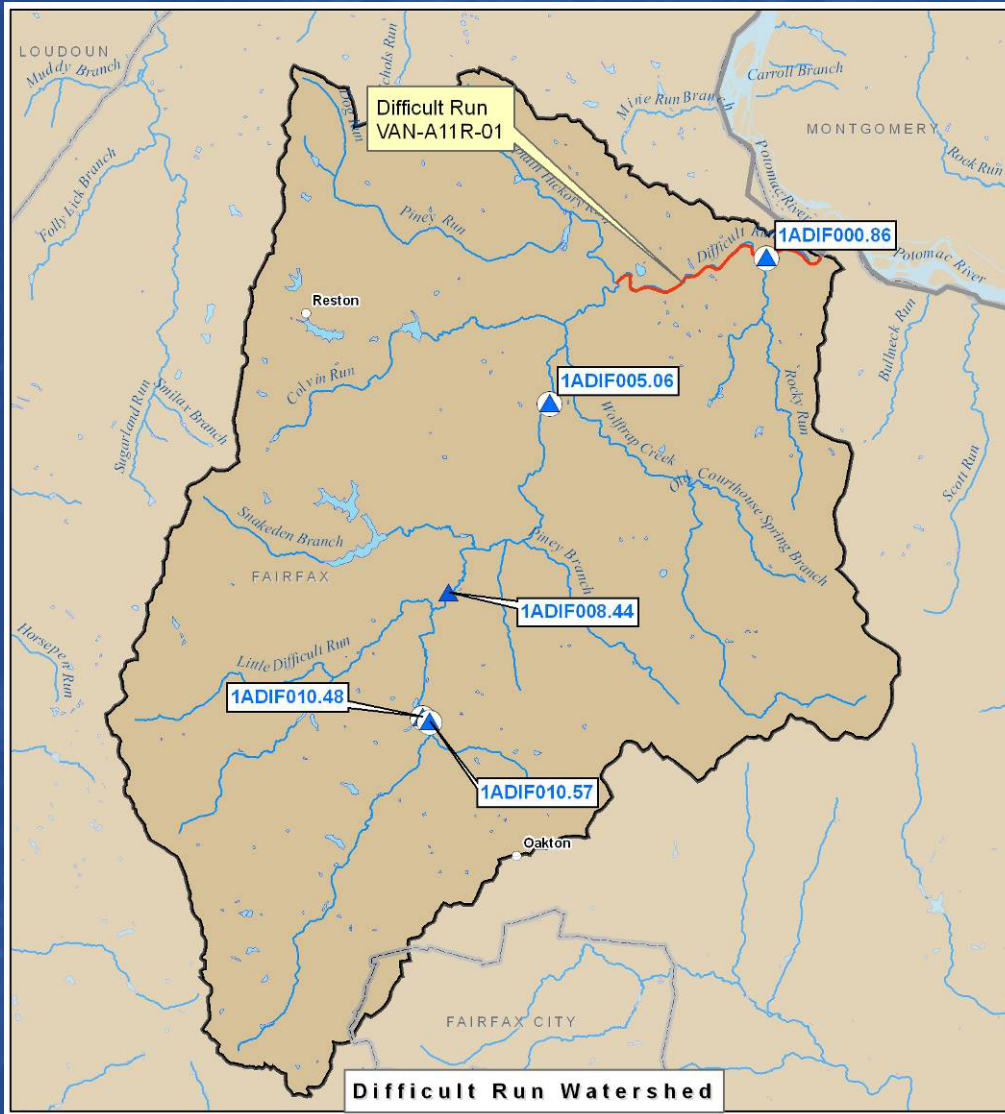Frequnecy Distribution of Oberved and Simulated Flows - Validation

Next Steps

- **Develop:**
  - Bacteria source loading estimates (Fecal Tool)
  - Model input parameters:
    - Hydrology and water quality
  - TMDL scenarios
- **Prepare Draft TMDL Report**

Benthic TMDL

Difficult Run Benthic Impairment

Difficult Run Watershed

TMDL ID: VAN-A11R-01

Length 2.93 miles
Benthic Impairment begins at the confluence of Captain Hickory Run and extends to the Confluence with the Potomac River.

The segment was first listed in 1994 for moderate benthic impairment.

Accotink Creek Benthic Impairment

Accotink Creek Benthic Sampling Stations
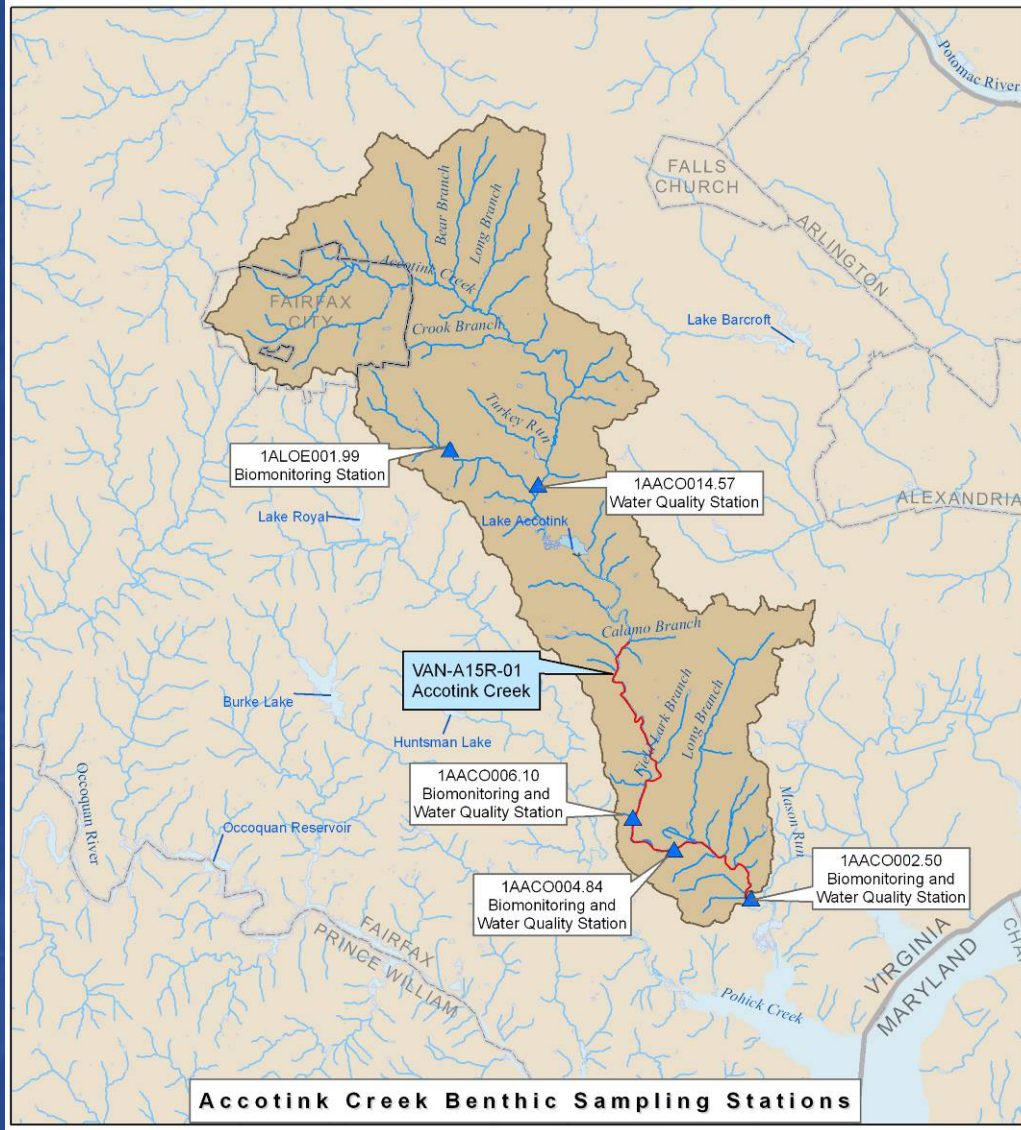
TMDL ID: VAN-A15R-01

Length 7.35 miles
Benthic Impairment begins at
the confluence of Calamo
Branch and extends to the
to end of free-flowing waters
(Rt. 1).

The segment was first listed in
1996 for moderate benthic
impairment.

Biological Monitoring

- ## Based on Biological Monitoring
  - Assessments indicate the benthic community is impaired.
  - Therefore, the listed segments do not meet the Aquatic Life Use support goal.

The General Water Quality Standard: "All state waters shall be free from substances […] which are harmful to human, animal, plant or aquatic life." (9 VAC 25-260-20).

Biological and Habitat Metrics

- **Virginia Stream Condition Index (VSCI)**
  - Incorporates 8 standard metrics based on the abundance and types of macroinvertebrates present at each station
  - Metrics are taken from stations located in the impaired segment as well as from several reference stations in non-impaired streams
  - Final score is based on a comparison of the combined reference sites with the impaired segment

- **Habitat Assessment Scores**
  - Suite of habitat variables were visually inspected at monitoring stations as part of the biological assessments
  - Habitat parameters examined include: epifaunal substrate, embeddedness, velocity, sedimentation, channel flow, channel alteration, frequency of riffles, bank stability, vegetation protection, and riparian zone
  - Parameters were assigned a score from 0 to 20, with 0 indicating very poor conditions and 20 indicating optimal conditions

Difficult Run Biological Scores

Average VSCI Score 1994 - 2007
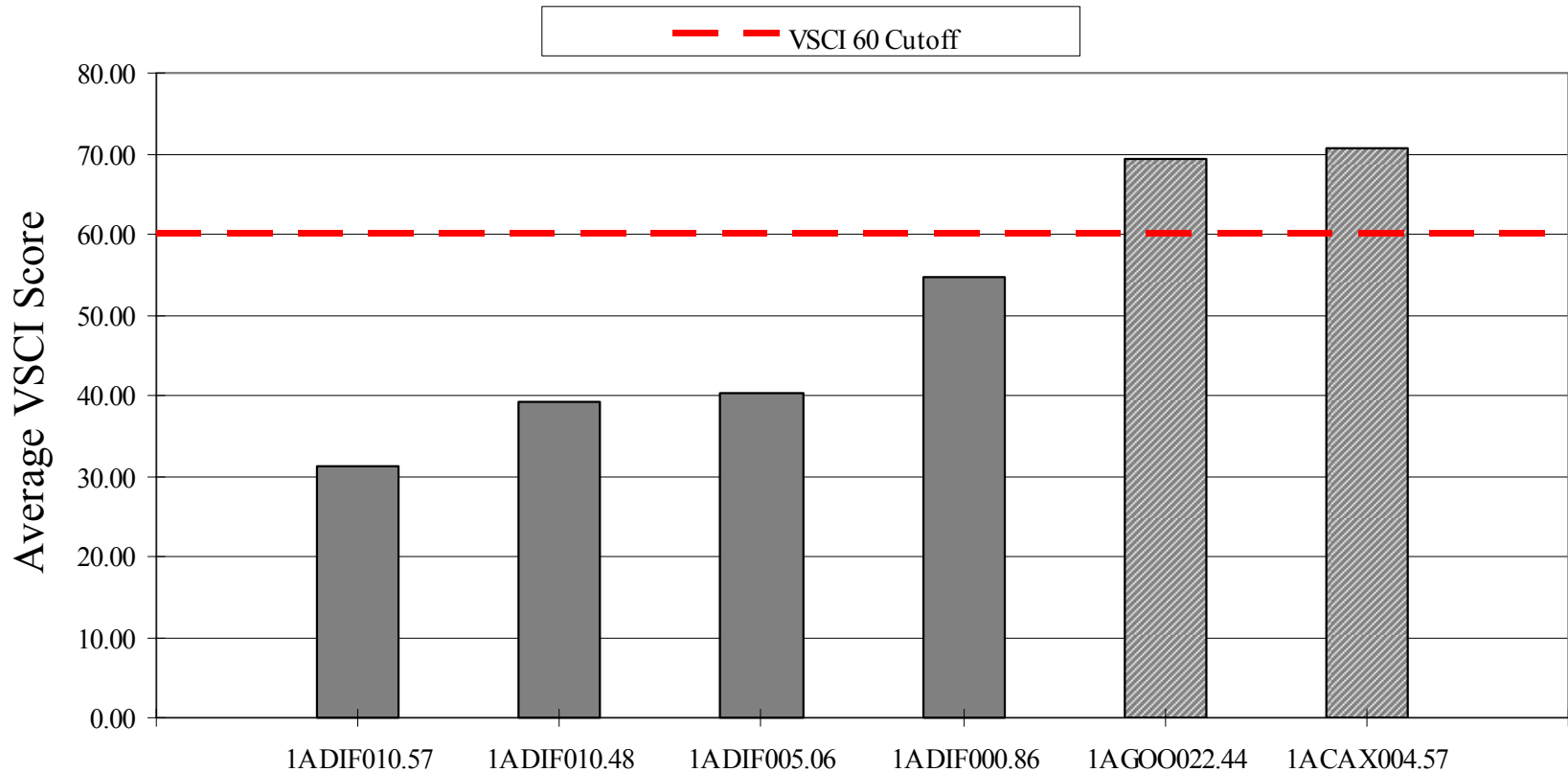
Difficult Run Habitat Score

1ADIF000.86 Habitat 1999 - 2007

Legend: ■ Bank Stability ▨ Veg Protection ▤ Riparian Zone
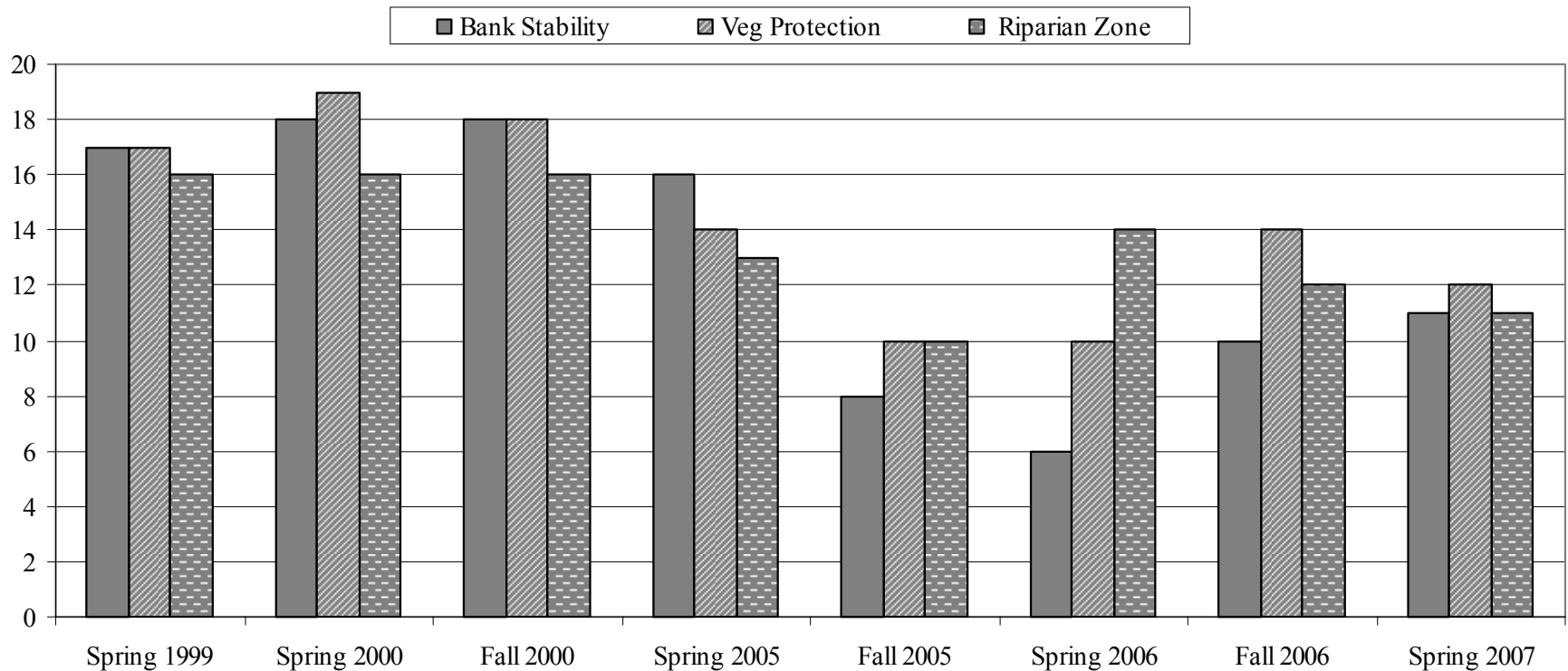
Benthic Stressor Identification

- **What pollutant(s) is causing the impairment of the benthic community?**

- **Common stressors include:**

  - **Dissolved Oxygen**
  - **Nutrients**
  - **pH**
  - **Temperature**
  - **Sediment**
  - **Toxics**

Data Used in Stressor Identification

Environmental Data:

1.   Biological and Habitat Assessment Data

1.   Water Quality Data
   - a)   Instream water quality data

2.   Toxicity Testing
   - a)   Acute toxicity testing
   - b)   Chronic toxicity testing

3.   Discharge Monitoring Reports (DMR)

5.   Biologists field notes and observations

Classification of Stressors

- <u>Non-stressors</u>: The stressors with data indicating normal conditions and without water quality standard violations, or without any apparent impact

- <u>Possible stressors</u>: The stressors with data indicating possible links, however, with inconclusive data to show direct impact on the benthic community

- <u>Most probable stressors</u>: The stressors with the conclusive data linking them to the poorer benthic community

Difficult Run Stressor Identification Summary

Non-Stressors
pH
Temperature
Dissolved oxygen
Nutrients (Nitrogen and Phosphorus)
Instream Metals
Instream Organic Chemicals
Possible Stressors
Toxicity
Heavy Metals and Organic Contaminants in Fish Tissue
Most Probable Stressors
Sedimentation and Urban Runoff

Difficult Run Non-Stressors

- *Temperature:* Field measurements indicated that adequate temperature values were recorded on the biologically impaired segments.

- *pH*: All recent pH measurements showed a suitable range for benthic invertebrates

- *Dissolved oxygen:* The field dissolved oxygen samples and the diurnal monitoring samples both complied with the dissolved oxygen standards.

- *Instream metals and dissolved organic chemicals*: The instream heavy metals data (including cadmium, chromium, copper, lead, nickel, silver, and zinc) were below the acute or chronic dissolved freshwater criteria specified in Virginia's aquatic life use standards.

Therefore, temperature, pH, dissolved oxygen, instream metals, and dissolved organic chemicals do not appear to be adversely impacting benthic communities in Difficult Run and are classified as non-stressors.

Difficult Run Possible Stressors

- **Possible stressors:**
  - *Toxicity:* Acute and chronic toxicity testing was conducted along the impaired segment.
    - These tests showed that there was a toxic effect of the *Ceriodaphnia dubia*, also known as water fleas, for both surveys.
    - There was no significant biological effects on fathead minnow survival and biomass.
    - These toxicity tests do not provide information on the source of the toxics that may be affecting the fish community.
    - During the sampling period of the toxicity test, there was major storm event which may affect the results.
  - *Heavy Metals and Organic Contaminants in Fish Tissue:* Data collected by VA DEQ at 1ADIF000.86.
    - Exceedances of mercury, heptachlor epoxides, and total PCBs screening values for fish tissue

Therefore, toxicity and heavy metals and organic contaminants in fish tissue is considered to be possibly impacting the biological community in Difficult Run

Difficult Run Most Probable Stressor

- Most Probable Stressors:
  - ➤ *Sedimentation and Urban Runoff:* Sedimentation and urban runoff have been identified as the most probable stressor in the Difficult Run benthic impaired segment based on the composition of the benthic community and benthic habitat data from the impaired station.
    - In particular, low habitat assessment scores for riparian zone vegetation, riffle frequency, and bank stabilization and protection.
    - DEQ Field Biologists noted impacts from NPS and storm sewer runoff were degrading habitat and potentially inhibiting the health of the aquatic community in the fall of 1996 and spring of 1997.
    - The impervious surfaces within the urban areas have increased the speed of runoff which can erode banks, scour stream beds, and deliver toxic chemicals.

Therefore, sedimentation and urban runoff are considered to be the most probable stressors impacting the biological community in Difficult Run.

Next Steps for Difficult Run Benthic TMDL

- **Finalize Stressor Analysis**
- **Develop technical approach**
  - ➤ Watershed model
  - ➤ Load duration curves
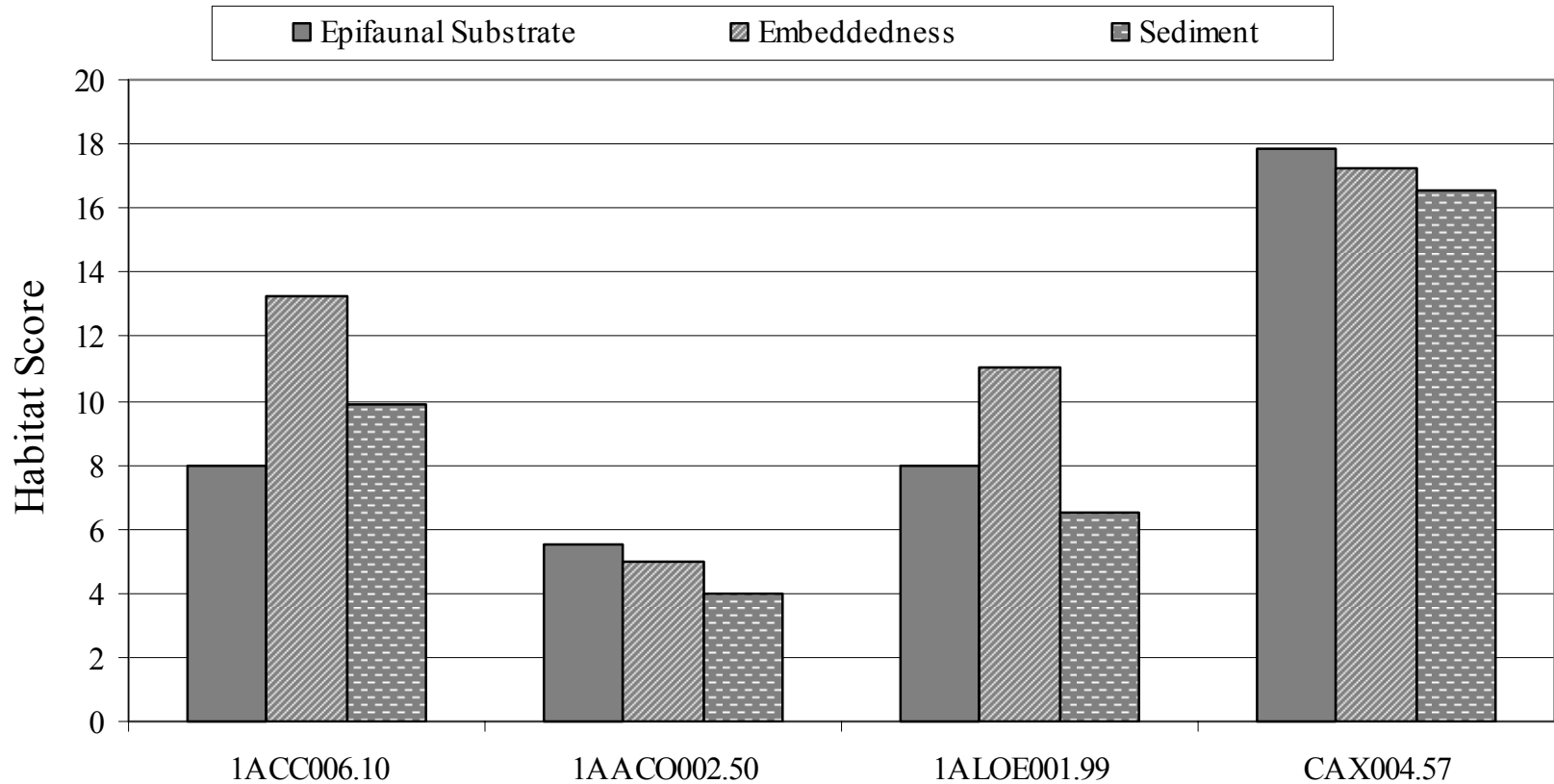- **Develop TMDL Allocation Scenarios**
- **Draft TMDL Reports**

Accotink Creek Biological Scores

Average VSCI Score 1994 - 2007
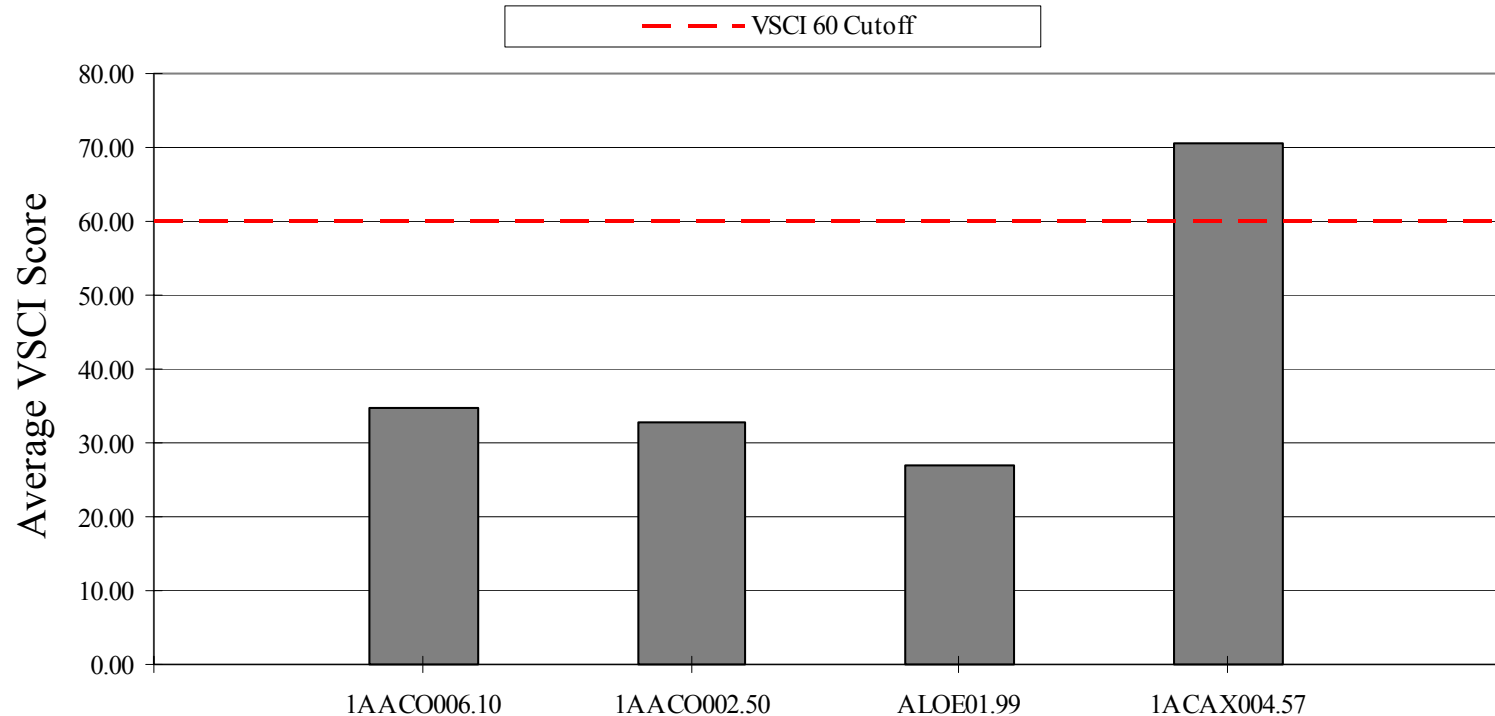
Accotink Creek Habitat Score

Selected Habitat Scores 1994 - 2006

Accotink Creek Benthic TMDL

- **Impairment Characterization:**
  - Low SCI and Habitat Scores.
  - Highly developed (83%) watershed.
  - Analysis points to the physical destruction of habitat (sedimentation, stream bank erosion, scouring) as the main stressor.
- **Regulatory/TMDL Issues:**
  - TMDL must be done for a "pollutant."
  - Questionable whether sediment reductions from overland sources alone would fix the impairment.
  - Want to investigate other potential stressors (not ruling out using sediment as the stressor).
- **Implications:**
  - Benthic TMDL for Accotink Creek will not be completed by the planned submission date of March 2008.

Pollutant vs. Pollution

- **<u>Pollutant</u>:**   Dredged spoil, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand, cellar dirt and industrial, municipal, and agricultural waste discharged into water. (CWA, Section 502, General Definitions)

- **<u>Pollution</u>:**   The man-made or man-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media. (CWA, Section 502, General Defintions)

Section 303(d) of the Clean Water Act and the Environmental Protection Agency's (EPA's) Water Quality Planning and Management Regulations (40 CFR Part 130.7) indicate that the TMDL must be developed for a specific pollutant.

EPA Approved Flow Related TMDLs

Stream Name: Potash Brook

Location: Near South Burlington, Vermont (EPA Region I)

Impairment: Aquatic Life Use – Impaired Benthic Biological Community

TMDL Established for: Stormwater runoff volume as a surrogate for the pollutant sediment and a variety of other stressors associated with stormwater.

Approved by EPA: 12/19/2006

http://www.epa.gov/region1/eco/tmdl/assets/pdfs/vt/potashbrook.pdf

Stream Name: Eagleville Brook

Location: Mansfield, Connecticut (EPA Region I)

Impairment: Aquatic Life Use – Impaired Benthic Biological Community

TMDL Established for: Percent impervious cover (percent impervious cover serves as a surrogate for the mix of pollutants in stormwater).

Approved by EPA: 03/28/2007

http://www.epa.gov/region1/eco/tmdl/assets/pdfs/ct/eaglevillebrook.pdf

What does this mean for the Accotink Creek Benthic TMDL?

- TMDL must be completed by 2010.

- DEQ will work with EPA and other stakeholders to determine the appropriate TMDL endpoint.

- Once the TMDL endpoint has been determined, the TMDL process will continue for Accotink Creek.

Local TMDL Contacts

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Reports/presentations available at:

www.deq.virginia.gov/tmdl/mtgppt.html

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